FUNCTIONAL ANALYSIS AND TREATMENT IN EARLY EDUCATION CLASSROOMS

BY

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Abstract: Despite repeated demonstrations of the efficacy of functional analysis (FA) to identify reinforcers responsible for the maintenance of problem behavior prior to the development of treatment, some researchers have questioned the ecological validity of FA, because the majority of studies report FAs conducted under controlled conditions that may not closely resemble settings in which problem behavior typically occurs. In the current investigation, functional analyses were conducted for young, typically developing children who displayed problem behavior (aggression or aggression and property destruction). All sessions were conducted in a classroom within the context of ongoing classroom activities. Subsequently, treatments based on the results of the FA were implemented to assess the validity of the outcomes of the functional analyses. The effect of functional analysis conditions on classroom levels of problem behavior were compared before, during, and after the assessment. Results are discussed in terms of the utility of classroom-based assessment and analysis of naturally occurring events that may compromise procedural integrity.

Functional Analysis and Treatment in Early Education Classrooms

It is common for typically developing children to engage in problem behavior (e.g., Ellingson et al., 2000; Lewis & Sugai, 1986; Mueller, Sterling-Turner, & Scattone, 2001). In a large-scale study on problem behavior in schools, Spaulding et al. (2010) reviewed office-discipline referral data from over 1,500 schools nationwide and found that 12% of elementary school children, 28% of middle school children, and 33% of high school children had been sent to the office for misconduct on more than two occasions during the 2005 to 2006 academic school year. The authors also found that the majority of office-discipline referrals were due to problem behavior directed towards a classmate for elementary school children, problem behavior directed towards an adult for middle school children, and various attendance issues for high school children. Although a variety of administration-levied consequences were arranged for office-discipline referrals in elementary schools, referrals often resulted in school detention or suspension for middle school and high school children. Some authors have noted that escape from problem behavior in the educational setting is a likely reinforcer for teacher behavior (Carr, Taylor, & Robinson, 1991), and these contingencies may lead school administrators to temporarily or permanently remove children who engage in problem behavior.

The prevention of school-related problem behavior has become a concern of childcare centers, as behavior problems that occur in school are likely to emerge before school admission (i.e., during the preschool years) and continue while children are in the school system (Carey, 2004). Votruba-Drzal, Coley, Maldonado-Carreno, Li-Grining, and Chase-Lansdale (2010) found the development of behavior problems later in childhood to be negatively correlated with the quality of childcare received early in life for 349 low-income children. Specifically, the authors defined quality childcare as programs that help children "learn to regulate their emotions, behaviors, and attention; to get along with peers; and to comply with rules and requests" (p. 1461). Many of the indices of quality childcare programs identified by the authors are the same results of an effective behavior management system (e.g., teaching appropriate social skills, delay tolerance, compliance, etc.). Therefore, it seems that the use of behavior management procedures with young children at risk for future problems in the school system might more easily be corrected while in early childcare settings than after school admission. Occasionally, system-wide behavior management procedures will require modification for some individuals. Individualized treatments for problem behavior should then be designed.

There is a rich empirical basis for the fact that treatment procedures based on the results of a functional analysis (e.g., Carr & Durand, 1985; Iwata, Dorsey, Slifer, Bauman, & Richman, 1994) produce better treatment outcomes than when treatments are not based on functional analysis results (Hanley, Iwata, & McCord, 2003; Iwata et al., 1994; Solnick & Ardoin, 2010). However, Hanley, Iwata, and McCord (2003) conducted a systematic review of the behavioral literature on functional analysis and found that although the vast majority of functional analysis studies included children, only 9% of reviewed studies included typically developing children. Additionally, in a recent review on functional analyses conducted in school settings, Solnick and Ardoin (2010) found that only 35.4% of reviewed articles included typically developing children, and the authors noted that additional research is needed on classroom-based functional analysis procedures. Therefore, typically developing children that engage in problem behavior at school and in early childcare settings represent a relatively understudied area in the assessment and treatment of problem behavior.

Although many variations of functional analysis exist (see Iwata & Dozier, 2008 for an overview), functional analyses are typically conducted in small well-controlled analogue environments (i.e., in session rooms) in which test and control conditions are arranged in a multielement design (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1994). However, some challenges to this functional analysis arrangement exist. First, it may be difficult to reliably attain assent from some children to leave their classroom to go to a session room. As review boards often require subject assent for functional analyses to be conducted, this poses some difficulty in ensuring the consistency with which assessment sessions should be conducted. An alternative solution is to conduct the functional analysis in the classroom environment. Classroom-based functional analyses would likely minimize subject refusal, therefore, allowing sessions to proceed.

Second, session rooms may not readily occasion problem behavior even if assent is attained. Low-to-zero rates of problem behavior across functional analysis conditions can be especially difficult from which to identify behavioral function, and several solutions have been proposed: (a) programming common stimuli (Stokes & Baer, 1977), (b) using a reversal design or conducting longer sessions (Vollmer, Iwata, Duncan, & Lerman, 1993; Wallace & Iwata, 1999), and (c) combining or enhancing programmed establishing operations (e.g., Smith, Iwata, Goh, & Shore, 1995). However, a simpler solution might be to only conduct functional analysis sessions in the environment in which problem behavior is already occurring (i.e., in the classroom) before making additional manipulations.

Third, it is possible that the function(s) of problem behavior identified in a session room functional analysis may not be the same functions or all the functions that would have been identified had the functional analysis been conducted in the classroom (Solnick & Ardoin, 2010). That is, the external validity of functional analyses conducted in session rooms may be low for some children. Arranging functional analysis conditions in the classroom environment would virtually eliminate this possibility.

Because of the potential problems of conducting a functional analysis in a session room, multiple studies have conducted functional analyses in classroom settings with children both with and without developmental disabilities (e.g., Broussard & Northup, 1995; Broussard & Northup, 1997; Sasso et al., 1992; Sigafoos & Saggers, 1992). For example, Broussard and Northup (1997) found that access to peer attention maintained the disruptive behavior of four typically developing children when classroom-based functional analyses were conducted, and a subsequent treatment based on the results of Solomon and Wahler (1973) used peers from each child's classroom to reduce problem behavior levels for each children. Similarly, Northup et al. (1995) found that contingent access to peer and not teacher attention served as positive reinforcement for the out-of-seat behavior and inappropriate vocalizations of three typically developing children. Collectively, the results of these studies as well as Broussard and Northup (1995) emphasize the role of classmate's behavior as a potential source of reinforcement for problem behavior of typically developing children in school settings.

It is important to note that a functional analysis is not the only type of behavioral assessment available in the classroom setting. Some authors have suggested the use of non-experimental methods (e.g., indirect and descriptive assessments) to identify behavioral function in applied settings (e.g., Lennox & Miltenberger, 1989). Unfortunately, numerous studies since have shown that the results of descriptive analyses do not necessarily correspond to functional analysis results and, therefore, alone appear insufficient in determining behavioral function (Hall, 2005; Lerman & Iwata, 1993; Mace & Lalli, 1991; Tarbox et al., 2009; Thompson & Iwata, 2007). However, descriptive assessments may have other uses in applied settings.

McKerchar and Thompson (2004) used descriptive assessments to better determine the environmental events that surrounded the problem behavior of 14 typically developing children and found that social stimuli commonly manipulated in functional analysis conditions (i.e., attention, escape, and tangible access) occurred naturally in preschools and often were delivered when problem behavior occurred. Although correlational, the results of McKerchar and Thompson (2004) suggest that functional analyses that test the effects of attention, escape, and access to materials on problem behavior may be appropriate in preschool settings with typically developing children.

Other possible uses for descriptive assessments in the classroom setting include identifying potential reinforcement contingencies or relevant stimulus conditions when initial functional analysis results are undifferentiated or inconsistent (e.g., Tiger, Hanley, & Bessette, 2006). Tiger, Hanley, and Bessette (2006) conducted a descriptive assessment to identify the conditions under which hand mouthing occurred for one child when initial functional analysis results were undifferentiated. The identification of stimuli present during naptime identified via a descriptive assessment, and the subsequent inclusion of those materials, enabled the identification of automatic reinforcement of problem behavior during a second functional analysis. Alternatively, descriptive assessments may be useful when inconsistent responding occurs across functional analysis or treatment conditions. For example, if data collected from a functional analysis clearly indicate behavioral sensitivity to social-positive reinforcement, but a subsequent function-based treatment proves ineffective, a descriptive analysis might be used to identify uncontrolled sources of influence (e.g., the delivery of tangible items by other children). Such information could then be used to better control the experimental arrangement when additional treatment sessions are conducted.

Although conducting functional analyses within the classroom context appears to be worthwhile, it is possible that doing so may increase problem behavior levels in the classroom. Some authors, including Vollmer, Borrero, Wright, Van Camp, and Lalli (2001), have questioned the use of potentially powerful continuous reinforcement schedules in functional analysis procedures. As behavioral acquisition is most likely under continuous reinforcement schedules (Cooper, Heron, & Heward, 2007), it is possible that exposing problem behavior to strong reinforcement contingencies (in addition to those reinforcement contingencies already present in the classroom) in the same environment in which problem behavior is already an issue may only exacerbate the problem, as stimuli present during functional analysis conditions remain present throughout the school day. However, research has shown continuous reinforcement schedules to be less resistant to extinction (Ferster & Skinner, 1957). More research on the potential effects of conducting classroom functional analyses on classroom problem behavior levels is needed.

The purpose of Study 1 was to conduct functional analyses in the context of ongoing classroom activities and to validate the functional analysis results with a function-based treatment. The purpose of Study 2 was to examine the role of classmate's delivery of potential reinforcing consequences for problem behavior that occurred during functional analysis and treatment sessions. The purpose of Study 3 was to assess the effects of conducting a functional analysis on overall levels of classroom problem behavior.

Study 1: Functional Analysis and Treatment of Problem Behavior

This study was designed to assess the function of children's problem behavior by conducting a functional analysis within regularly scheduled activities of an early education classroom. Specifically, we were interested in the feasibility of conducting functional analysis conditions within a classroom context and whether treatment procedures developed from the results of each functional analysis would decrease problem behavior levels. If function-based treatments were shown to reduce problem behavior, the classroom-based functional analysis would likely constitute a valid assessment tool when used with other typically developing children in similar classroom settings.

Subjects and Setting

Five young, typically developing children enrolled in a university-based preschool participated in Study 1. All subjects engaged in problem behavior at levels higher than or more severe than their classmates. Dillon (2 years old), Hank (3 years 1 month old), and Missy (1 year 4 months old) engaged in aggression. Doug (3 years 9 months old) and Jim (1 year 9 months old) engaged in both aggression and property destruction. All sessions were conducted in each child's respective classroom, where total enrollment ranged from 12 to 20 children.

Response Measurement and Interobserver Agreement

Problem behavior targeted for all subjects consisted of aggression, property destruction, or both. Frequency data were collected on *aggression*, which was defined as any behavior that could result in injury to another individual (e.g., hitting, kicking, pushing, shoving, hair pulling, pinching, spitting, biting, etc.). Across all sessions, therapists were instructed to block instances of aggression directed at another child, and when necessary, reposition the other child to ensure safety. Frequency data were also collected on *property destruction* for Doug and Jim and was defined as any inappropriate use of materials that could result in damage to the materials (e.g., throwing, hitting, kicking, banging, stomping, or ripping objects). Functional play (e.g., banging a hammer) as well as mouthing objects was not scored as property destruction. Additionally, frequency data were collected on independent mands throughout treatment conditions.

Independent mands were defined as any unprompted vocal request for the putative reinforcer relevant to a given condition (e.g., saying "play with me" during the attention condition of the functional analysis).

A second observer independently collected data on aggression, property destruction, and independent mands on 30.2% of functional analysis and treatment sessions. An agreement was defined as both observers recording the same response in a 10-s interval. Interobserver agreement coefficients were calculated using proportional agreement in which the smaller number of responses was divided by the larger number of responses within each interval. Agreement coefficients were then averaged across each interval of each session and multiplied by 100 to yield a percentage. Mean interobserver agreement across subjects averaged 98.9% for aggression (range, 93% to 100%), 97% for property destruction (range, 70% to 100%), and 94% for independent mands (range, 74.5% to 100%).

Functional Analysis Procedure

Functional analysis procedures were similar to those outlined by Iwata, Dorsey, Slifer, Bauman, and Richman (1994). However, all sessions took place in each child's classroom during the course of regularly scheduled free-play activities, and the target child was allowed to engage in the ongoing activity with the other children across sessions. Graduate teaching assistants conducted all sessions, and trained graduate and undergraduate students collected data. During all sessions, classroom teachers were provided general instructions to not interact with the target child. All sessions were 10 min in duration and took place in various areas of each child's classroom during free-choice play periods. Sessions were divided into 10-s intervals for the purpose of data analysis. Different colored shirts and different therapists (when possible) were associated with the functional analysis conditions to facilitate discrimination of the programmed contingencies. Additionally, brief pre-session statements regarding the contingencies of the upcoming session were typically delivered to better enable discrimination. The experimental designs used during functional analyses and treatment analyses included multielement, pairwise, and reversal designs. All sessions were videotaped.

Ignore. (Hank, Doug, Jim) The ignore condition of the functional analysis was conducted with children for whom problem behavior was thought to have a potential automatic function. During this condition, the therapist ignored all instances of problem behavior displayed by the target child and interacted continuously with the other children. All other responses emitted by the target child were similarly ignored. The purpose of this condition was to determine whether problem behavior occurred in the absence of socially mediated contingencies (i.e., to access sources of automatic reinforcement).

Attention. The therapist interacted continuously with the other children and minimized interaction with the target child. However, the therapist delivered 3 to 5 s of attention (e.g., statements of concern, disapproval, etc.) to the target child contingent on instances of problem behavior. All other responses emitted by the target child were ignored. This condition was conducted to determine whether problem behavior was sensitive to social positive reinforcement in the form of adult attention.

Escape. A three-step prompting procedure (i.e., vocal, model, physical) was used to deliver instructions to the target child during ongoing activities. Instructions typically included receptive identification tasks (e.g., “point to the blue block”), gross-motor tasks (e.g., “sit in the chair”), and fine-motor tasks (e.g., “stack the blocks”). While all tasks were not explicitly stated in each child’s individualized curriculum, the instructions delivered during the escape condition were comprised of common instructions delivered in each child’s classroom. A 30-s break from instructions was provided contingent on instances of problem behavior. Brief praise was delivered for compliance with either the vocal or model prompt of the three-step prompting procedure. The purpose of this condition was to determine if problem behavior occurred to escape from instructions commonly delivered in each classroom.

Tangible. Prior to the start of the tangible condition, the target child was permitted 2-min access to classroom play materials that were presently available as dictated by a classroom toy-rotation schedule. After 2 min of presession exposure, all play materials were removed at which point the 10-min tangible condition began. During this condition, 30-s access to play materials was provided contingent on problem behavior. The purpose of the tangible condition was to evaluate whether problem behavior occurred to access presumably preferred classroom play materials.

Play (control). The therapist continuously interacted with the target child and avoided the delivery of demand statements and questions during this condition. All instances of problem behavior were ignored. This condition served as a control condition from which levels of problem behavior during test conditions were compared.

Functional analysis sessions were conducted until consistently higher levels of problem behavior in at least one of the test conditions were observed relative to those observed during the play (control) condition. For most children, additional experimental designs (i.e., consecutive ignore sessions, pairwise, and reversal designs) were required to better identify behavioral function. Subsequently, we evaluated the effects of a treatment for problem behavior maintained by the contingencies identified by each subject’s functional analysis.

Treatment Evaluation Procedure

Treatment procedures were based on the results of each child's functional analysis and consisted of differential reinforcement of alternative behavior (DRA) and extinction (EXT) or timeout (TO). Reversal and multiple-baseline designs were used to demonstrate experimental control during treatment evaluations.

TX (DRA+EXT). (Missy, Doug, Jim) During this condition, problem behavior no longer resulted in the delivery of the reinforcer identified in the functional analysis. For example, if access to attention was identified as the likely maintaining variable of problem behavior during the functional analysis, the therapist would ignore the occurrence of problem behavior during this condition. Additionally, independent mands specific to the reinforcer identified in the functional analysis resulted in the delivery (positive reinforcement) or removal (negative reinforcement) of that stimulus. For example, if escape from instructions was identified as the reinforcer for problem behavior in the functional analysis, "break, please" or any equivalent vocal response that identified escape as a reinforcer would result in a 30-s break from instructions (i.e., the delivery of reinforcement). However, "play with me" would not result in a break, as the response does not specify escape as its reinforcer. Additionally, if an independent mand for the functional reinforcer had not occurred within the last 1 min, the therapist delivered the prompt "(child's name), remember that you can ask for (functional reinforcer)" or a similar prompt specifying the availability of reinforcement. This treatment condition was conducted to determine whether differential reinforcement for an alternative (appropriate) response combined with extinction for the problematic response would effectively reduce levels of problem behavior and result in maintained levels of appropriate behavior.

TX (DRA+T.O.). (Dillon, Missy, Doug, Jim) During this condition, independent mands for the reinforcer identified in the functional analysis resulted in reinforcement. However, problem behavior resulted in the removal of reinforcement (i.e., timeout) for each child. Specifically, the child was immediately guided to an area outside the free-choice location and required to sit facing the class for 1 min contingent on the occurrence of problem behavior. During this period, the therapist continued to engage with the other children in the classroom. Problem behavior that occurred during timeout was ignored, and the target child was invited "back to play" when the 1-min interval elapsed. Similar to the DRA with extinction treatment procedure, a prompt was delivered every minute in which an independent mand for the functional reinforcer had not been emitted. This treatment condition was conducted to determine whether differential reinforcement for an alternative (appropriate) response combined with the removal of reinforcement contingent on the problematic response would effectively reduce levels of problem behavior and result in maintained levels of appropriate behavior.

Results and Discussion

Functional analysis data for Dillon, Hank, Missy, Doug, and Jim are presented in Figure 1. For Dillon, higher levels of aggression were observed in both the attention and tangible conditions relative to those observed in play, suggesting that Dillon's aggression was maintained by social positive reinforcement in the form of access to both attention and tangible items.

During the initial multielement phase of Hank's functional analysis, aggression consistently occurred in the attention condition, albeit at low levels. Instances of aggression rarely occurred in the demand, tangible, and play conditions. This pattern of responding suggested that aggression was maintained, at least in part, by social positive reinforcement in the form of access to adult attention. However, aggression occurred inconsistently in the ignore condition. Hank's occasional responding during the ignore condition was believed to be due to either automatic reinforcement or to a discrimination failure between the rapidly alternating conditions of the multielement design (Vollmer et al., 1993). Therefore, consecutive ignore sessions were conducted (Vollmer, Marcus, Ringdahl, & Roane, 1995). Initially, we observed a moderate but variable level of aggression during the consecutive ignore sessions. However, aggression decreased over the course of sessions, suggesting that aggression was not maintained by automatic reinforcement and that previous responding during ignore conditions in the multielement design was likely due to discrimination failure. To replicate higher levels of aggression observed during the attention condition relative to those observed during play, additional attention and play sessions were conducted in a pairwise design (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994). Consistently higher levels of aggression were observed during the attention condition relative to the play condition. These results provided additional evidence that Hank's problem behavior was sensitive to social positive reinforcement in the form of adult attention.

The multielement phase of Missy's functional analysis produced intermittent instances of problem behavior during several attention, tangible, and play sessions. However, consistently higher levels of responding during the attention condition relative to those observed during the play condition were observed in subsequent pairwise phases in which attention and play conditions alternated. No problem behavior was observed during the tangible and play pairwise phase. These results suggested that Missy's aggression was also maintained by social positive reinforcement in the form of adult attention.

Doug's functional analysis data were analyzed with each topography of problem behavior separated to ensure that additional functions were not masked (Derby et al., 2000); however, similar responding was observed across topographies. The multielement phase of Doug's functional analysis produced higher levels of problem behavior during the attention, ignore, and tangible conditions relative to those observed in play. A slight overall decrease in the level of problem behavior was observed during the consecutive ignore phase; however, responding never extinguished. A subsequent pairwise design produced higher levels of problem behavior during the attention condition relative to those observed during the play condition, and no problem behavior occurred during the subsequent tangible and play pairwise phase. These results suggest that problem behavior for Doug was sensitive to attention.

Jim's functional analysis data were also analyzed by each topography of problem behavior to ensure the correct identification of behavioral function for both aggression and property destruction (Derby et al., 2000); however, similar response patterns were observed. The multielement phase of Jim's functional analysis produced elevated levels of problem behavior during the attention, ignore, and play sessions. Continued responding was observed under the subsequent consecutive ignore phase. However, during this phase, therapists and data collectors noticed that Jim occasionally received interaction from his classmates following instances of problem behavior. Therefore, we attempted to control for this possible source of influence by removing Jim's teachers and peers from the classroom, and levels of problem behavior subsequently decreased. Higher levels of problem behavior were again observed during the attention condition relative to those observed during the play condition in the following pairwise phase. The results of Jim's functional analysis suggest that attention likely maintained his aggression and property destruction.

Treatment procedures based on the results of each child's functional analysis were then evaluated for Missy, Doug, Jim, and Dillon. Treatment procedures for Hank, although based on the results of a functional analysis, were outside the scope of the current study. Therefore, treatment data for Hank are not presented. Treatment evaluation data for Missy, Doug, and Jim are presented in Figure 2. Differential reinforcement of alternative behavior and extinction was initially introduced to decrease levels of Missy's problem behavior. Initial exposure to DRA and extinction produced near-zero levels of problem behavior and consistent levels of independent mands for attention. However, following a return to baseline contingencies in which higher levels of problem behavior were observed, consistently low levels of problem behavior were not replicated during the second DRA and extinction treatment evaluation. Therefore, DRA with timeout was evaluated. Initial implementation of DRA with timeout resulted in low levels of problem behavior and consistent levels of independent mands. A brief return to baseline procedures did not result in higher levels of problem behavior previously observed during baseline; however, a decrease in the level of independent mands was observed. Higher levels of independent mands and continued zero levels of problem behavior were observed when DRA with timeout was reintroduced. Next, the DRA with timeout treatment procedure was taught to Missy's classroom teachers. However, when classroom teachers implemented the treatment procedure previously shown to be effective, higher levels of problem behavior and low levels of independent mands were observed.

Treatment integrity measures were then calculated by determining errors of omission for correct implementation of both the DRA and timeout components of the treatment. Correct implementation of timeout was defined as implementing timeout during the same interval or during the interval immediately following an instance of problem behavior. Implementation of DRA was deemed correct if the functional reinforcer was delivered during the same interval or during the interval immediately following the emission of an independent mand. When classroom teachers initially implemented DRA with timeout for Missy's problem behavior, treatment integrity measures for implementing the correct consequence for problem behavior were low (DRA: 85% and timeout: 33%). Trained therapists again demonstrated the effectiveness of DRA with timeout in the subsequent phase in which zero occurrences of problem behavior and higher levels of independent mands were observed. Treatment integrity measures were higher for correctly implementing DRA (98%); however, treatment integrity on correct implementation of timeout was not possible due to zero levels of problem behavior during this phase. Missy's classroom teachers again implemented DRA with timeout in the last phase of the treatment evaluation. However, trained therapists provided in situ training to the classroom teachers that consisted of prompts to deliver attention each minute when an independent mand had not occurred and to implement correct consequences for independent mands and problem behavior. Feedback regarding correct and incorrect implementation of the treatment procedures was also delivered. In situ training resulted in better implementation of DRA and timeout (DRA: 89% and timeout: 100%) by the teachers and more importantly, lower overall levels of problem behavior were observed.

Similar to the results of Missy's treatment evaluation, initial implementation of DRA with extinction appeared to reduce Doug's problem behavior. However, low levels of problem behavior did not maintain during the second evaluation of DRA with extinction for Doug. Differential reinforcement with timeout produced lower levels of problem behavior and higher levels of independent mands as compared to baseline levels across the three evaluations when implemented by trained therapists. Slightly higher overall levels of problem behavior were observed when Doug's classroom teachers implemented DRA with timeout. Like Missy's data, treatment integrity was poor (DRA: 73% and timeout: 0%) when classroom teachers implemented DRA with timeout when in situ training was not provided as compared to treatment integrity measures when implemented by a trained therapist in the phases just prior to (DRA:

97% and timeout: N/A) and just after (DRA: 96% and timeout: 100%) the teacher-implemented phase. Unfortunately, additional teacher training was not possible due to time constraints.

For Jim, DRA with extinction also failed to maintain suppressed levels of problem behavior relative to those observed in baseline. Low levels of problem behavior and high levels of independent mands were observed when trained therapists implemented DRA with timeout. Similar to the results of Missy's and Doug's treatment evaluation, overall treatment gains deteriorated when classroom teachers implemented DRA with timeout until in situ training was provided. Treatment integrity measures for Jim's data indicated that poor teacher implementation of both DRA (44% and 60%) and timeout (26% and 7%) components were the cause. Slightly better teacher implementation of DRA with timeout was observed when in situ training was provided (DRA: 86% and timeout: 50%).

Treatment data for Dillon are presented separately in Figure 3. For Dillon, moderate to high levels of aggression were observed during baseline for the attention and tangible functions. Differential reinforcement with timeout was implemented for the attention function first. Problem behavior during treatment decreased to near-zero levels, and mands maintained at high levels. Interestingly, an increase in baseline levels of problem behavior was observed in the tangible condition when DRA with timeout was implemented for the attention function. When the order of attention treatment and tangible baseline sessions were reviewed, sessions for each condition type were found to be well interspersed across time. Therefore, a possible contrast effect was observed in Dillon's data when DRA with timeout was implemented for the attention function. Differential reinforcement with timeout was then implemented for the tangible function, and the results were similar to those of the attention function.

Although none of the functional analyses conducted in the classroom setting were completed solely using a multielement design, the functional analyses were effective at identifying a reinforcement contingency likely maintaining elevated levels of problem behavior for each child. However, the results of the treatment evaluations were somewhat strange in that DRA with extinction was not effective at reducing problem behavior levels for any of the three children for whom it was implemented, whereas DRA with timeout was effective for all four children. Similar to reinforcement and punishment, operant extinction is defined functionally (Cooper, Heron, & Heward, 2007). That is, extinction has not occurred unless a decrement in responding is observed when reinforcement is no longer provided for the response on which its delivery was once contingent (Carr, Coriaty, & Dozier, 2000). In other words, if the discontinuation of the putative reinforcer(s) does not lead to the eventual decrease in response rate, extinction has not occurred. The failure of DRA with extinction to effectively extinguish problem behavior for the children in this study could have been due several reasons.

First, it is possible that a nonfunctional or neutral stimulus was being withheld contingent on problem behavior in treatment. In this case, extinction would not likely occur, because responding would presumably still access reinforcement. The possibility that a nonfunctional reinforcer was being withheld is unlikely, however, given that the functional analysis identified at least one reinforcer for each subject, and that stimulus was then restricted during treatment. Also, functional analysis and treatment sessions were conducted in the same environment (i.e., each child's respective classroom) further minimizing the possibility that a nonfunctional stimulus was withheld during treatment.

Another possibility for the ineffectiveness of DRA with extinction is that responding was multiply controlled. It is conceivable that although the functional analysis identified at least one reinforcer, problem behavior may have persisted because all sources of reinforcement were not withheld. For example, responding would likely persist if it were maintained by access to both social and automatic reinforcement in the event that only social reinforcement was removed. The possibility of multiple control is also not likely, because DRA with timeout (the removal of sources of social interaction) was demonstrated to be effective for all children. Differential reinforcement and timeout would likely only be effective for behavior maintained by social positive reinforcement as sources of automatic reinforcement would still be available, and the removal of social interaction contingent on a response would likely strengthen behavior maintained by escape.

A third possibility for the ineffectiveness of DRA with extinction is that too few responses contacted extinction for an eventual decrease in response rate to have been observed. Repeated sessions of DRA with extinction for all three subjects and multiple phases of DRA with extinction for two subjects were conducted to minimize this possibility.

A fourth potential reason for the ineffectiveness of DRA with extinction is a lack of experimental control. As noted by Lang et al. (2008), conducting functional analysis and treatment sessions within the context of ongoing early education classrooms and other "naturalistic" environments reduces the experimenter's ability to control all potential sources of influence. Although attempts were made to reduce the effect of potentially influential variables (e.g., conducting sessions during free-choice periods, instructing teachers across sessions not to interact with the target child, programming discriminative stimuli, etc.), one potentially important variable was not controlled: the behavior of the other children in the classroom (Broussard & Northup, 1995; Broussard & Northup, 1997; Northup et al., 1995). While conducting functional analysis and treatment sessions, therapists and data collectors noticed that each subject's classmates often delivered attention and occasionally delivered tangible items following problem behavior. It is possible that subject's interactions with their classmates influenced responding across conditions of the functional analysis and the treatment evaluation. For example, if problem behavior was demonstrated to be sensitive to attention in the functional analysis and therapist attention was effectively withheld during the DRA with extinction treatment evaluation but was provided by the subject's classmates on an intermittent schedule, problem behavior would not likely extinguish. Therefore, Study 2 analyzed the potential role of classmate's behavior in maintaining each participant's problem behavior during the functional analysis and treatment evaluation for each subject.

Study 2: Examining Uncontrolled Sources of Influence: Peer Behavior

Subjects and Setting

The videotaped functional analysis and treatment evaluation sessions were reviewed and rescored for interactions between each subject and his or her classmates. Because problem behavior for each subject was shown to be sensitive to social positive reinforcement during the functional analysis, we were specifically interested in peer delivery of attention and materials. Specifically, we were interested in the probability of peer delivery of attention and materials given problem behavior (i.e., the conditional probability) as compared to the probability of their delivery regardless of problem behavior (i.e., the response-independent probability).

Response Measurement and Interobserver Agreement

The following behavioral measures and probability calculations were based on Camp, Iwata, Hammond, and Bloom (2009) and McKerchar and Thompson (2004) to calculate conditional and response-independent probabilities of peer attention and peer material delivery for each subject. *Attention* (10-s partial interval) was recorded when any peer vocal or physical interaction occurred with the target child. Peer-delivered instructions occurred infrequently for each child and were not scored as attention delivery. *Materials provided* (frequency) was recorded when a peer presented to the target child an item or allowed access to previously restricted item. Toy-struggle situations in which the target child obtained materials not previously in his or her possession were also scored as materials provided.

A second observer independently collected data on peer-delivered attention and materials provided on 17.5% of functional analysis and treatment sessions. Mean interobserver agreement across subjects averaged 95.3% for attention (range, 70% to 100%) and 99.4% for materials provided (range, 92% to 100%). Some videos (including Missy's functional analysis videos and 18 videos from Hank's functional analysis) were lost due to hard drive failure or to error and are not included in the subsequent analyses. Also, videos were not scored from Jim's functional analysis phase in which teachers and peers were removed from the classroom, as there were no opportunities for peer interaction during these sessions.

Procedure

The response-independent probability of classmate's delivery of attention across functional analysis and treatment evaluation sessions was calculated for each subject by dividing the number of intervals in which peer attention was provided by the total number of intervals. Calculation of the response-independent probability of classmate's delivery of materials across all sessions was similar, except that frequency data on materials provided was first converted to partial interval data prior to each probability calculation.

The conditional probability of classmate's delivery of attention given problem behavior was calculated by first determining the intervals in which problem behavior occurred. If peer attention was delivered in the same 10-s interval or in the interval immediately following the interval with problem behavior, the interval with problem behavior was scored. The number of scored intervals were then summed and divided by the total number of intervals with problem behavior. The same calculation was also used to determine the conditional probability of classmate's delivery of materials for each subject.

Once response-independent and conditional probabilities were calculated for each subject, contingency values were calculated by subtracting the response-independent probability of each peer-delivered stimulus from the conditional probability of the same peer-delivered stimulus given problem behavior (McKerchar & Thompson, 2004; Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001). This additional calculation was conducted to assist the reader to more quickly identify potential reinforcement contingencies present within the functional analysis and treatment evaluation sessions. For subjects that engaged in both aggression and property destruction (Doug and Jim), separate contingency values were calculated for each topography of problem behavior.

When mean contingency values are above 0, a possible reinforcement contingency exists between a target response (i.e., the subject's problem behavior) and the stimulus delivered (in this case, the peer's delivery of attention or materials). As contingency values approach 1.0, a stronger contingency is present in which a greater proportion of problem behavior results in the delivery of the stimulus. At a contingency value of 1.0, a dependency would be said to exist wherein stimulus delivery occurs if and only if the response occurs (Lattal, 1995; Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001). Large negative contingency values would likely indicate therapeutic environments in which stimulus deliveries are more often delivered noncontingently than contingent on problem behavior.

Results and Discussion

Mean contingency value data of peer-delivered attention and materials during functional analysis and treatment-evaluation sessions for Dillon, Hank, Missy, Doug, and Jim are presented in Figure 4. For all subjects, mean contingency values of peer attention delivery were above 0 indicating that attention directed to the subject from other children in the classroom was more likely to be delivered in the same or subsequent 10-s interval as problem behavior than was peer attention delivery regardless of problem behavior. That is, even though the availability of therapist-delivered consequences (e.g., attention) were programmed to occur only during specified periods (e.g., following independent mands during treatment sessions), other children in the classroom delivered attention to the subject while problem behavior was occurring or following the occurrence of problem behavior more often than when problem behavior had not occurred. Topography-specific mean contingency values of peer attention delivery for Doug and Jim were higher for aggression than property destruction. These results are not entirely surprising as all subjects (including Doug and Jim) engaged in aggression towards peers more often than towards adults, and the presence of another individual is a prerequisite for aggression.

Mean contingency value data for peer-delivered materials, however, was found to be approximately zero for all subjects with the exception of aggression for Doug. Throughout Doug's functional analysis and treatment evaluation, peers were slightly more likely to deliver materials to Doug close in time to Doug's aggression; however, Doug's peers were more likely to deliver attention than materials during or following aggression.

Study 3: Assessing Generalization on Classroom Problem Behavior

Subjects and Setting

In addition to the data collected during functional analysis and treatment sessions, teachers in each subject's classroom collected data on problem behavior that occurred before, during, and after the general time in which each functional analysis was conducted to assess the effects of conducting a functional analysis on overall levels of classroom problem behavior.

Response Measurement and Procedure

Data on aggression (Dillon and Hank) or aggression and property destruction (Doug and Jim) were collected as frequency and then converted to responses per hour (Hank) or collected using a 15-min partial interval system and then converted to a percentage (Dillon, Doug, and Jim). All data were collected Monday through Friday across 7-hour days (9:30 a.m. to 4:30 p.m.). Therefore, there were 28 possible observation intervals in which teachers recorded instances of problem behavior for Dillon, Doug, and Jim. Throughout the school day, problem behavior for all children resulted in either a 1-min timeout from ongoing play activities or redirection to another activity.

When functional analysis or treatment evaluation sessions were conducted between 9:30 a.m. and 4:30 p.m., session times were subtracted from the 7-hour day, and any problem behavior that occurred during session was not included in the classroom problem behavior data. That is, problem behavior data from Study 1 are not included in the data for Study 3. More specifically, for Dillon, Doug, and Jim, for each 10-min session conducted in one day, one 15-min interval of classroom problem behavior data was removed from the 28 total intervals. Because frequency data were collected for Hank's problem behavior in the classroom, each 10-min session conduced in one day resulted in the removal of 10 min from the 7-hour day in which classroom data collection was recorded. Therefore, depending on the number of functional analysis and treatment sessions conducted in one day, some school days had a shorter observation time period for classroom problem behavior (i.e., a fewer number of possible observation intervals for classroom problem behavior data) than others. This was done to ensure that problem behavior levels during the functional analysis periods were not artificially low due to the inclusion of intervals of classroom problem behavior data in which there was no opportunity for classroom problem behavior to occur, because sessions were conducted those days.

Results and Discussion

Classroom problem behavior data are presented in Figure 5 with linear regression lines depicting problem behavior levels before, during, and after school days in which functional analysis sessions were conducted. Overall levels of problem behavior for Dillon, Hank, Doug, and Jim were variable throughout each time period. For Dillon, Hank, and Jim, a slight increasing trend in problem behavior was observed prior to the general period in which the functional analysis was conducted. Doug's problem behavior levels remained stabile before his functional analysis.

Problem behavior levels remained relatively stabile during the functional analysis period for all subjects, and slight decreases in classroom problem behavior levels were observed during the functional analysis periods for Dillon and Doug. Slight decreases in classroom problem behavior levels were observed following Dillon's functional analysis, and classroom problem behavior levels for Doug remained relatively low with slightly less variability than problem behavior levels before the functional analysis. However, post-functional analysis classroom data for Jim showed a slight increasing trend in problem behavior levels than those observed before or during the functional analysis. Problem behavior data collected in the classroom by each child's respective teachers showed little to no change in classroom levels of problem behavior before, during, or after the classroom-based functional analysis for all subjects, and for two subjects (Dillon and Doug) the functional analysis period was correlated with a slight decrease in problem behavior.

General Discussion

The inclusion of functional analyses in designing better-informed and more effective treatments for problem behavior has been noted repeatedly in the behavioral literature (Hanley, Iwata, & McCord, 2003; Iwata et al., 1994; Solnick & Ardoin, 2010). This study, along with others (e.g., Broussard & Northup, 1995; Broussard & Northup, 1997; Sasso et al., 1992; Sigafoos & Saggers, 1992), successfully conducted functional analysis and treatment evaluation conditions within the context of more typical environments experienced by young children. However, some qualifications should be presented. First, for 4 of the 5 subjects, a large number of sessions (i.e., more than 55) were required to determine behavioral function. The results of Study 2 suggested that uncontrolled sources of influence (i.e., classmate's behavior) present across functional analysis and treatment sessions were likely the cause. It is also likely that had a different progression of experimental designs been used in the functional analyses, behavioral function may have been more quickly identified, as data from initial multielement phases were inconclusive for all but 1 subject. For example, a better progression of experimental designs might first begin with consecutive ignore sessions to rule in or out the possibility of automatic reinforcement (Vollmer, Marcus, Ringdahl, & Roane, 1995). If a decrease in problem behavior levels is observed across sessions, pairwise phases in which test and control conditions are arranged might follow. If functional analysis data are still inconclusive, within-session descriptive assessment data may be useful in determining uncontrolled sources of influence (e.g., the behavior of other individuals present during the functional analysis). If low-to-zero levels of responding are observed during the functional analysis, descriptive assessment data collected outside functional analysis session times may be used to identify stimuli not yet included in the functional analysis (Tiger, Hanley, & Bessette, 2006). Subsequent functional analysis sessions could then better control previously unaccounted for sources of influence or include antecedent stimuli to more reliably occasion problem behavior.

In some cases, especially those in which resources are limited, the complexity of conducting a functional analysis within the typical classroom arrangement may prove too difficult or cumbersome. In these cases, it might be worthwhile to conduct sessions when the majority of the other students are out of the classroom (e.g., during recess or a fieldtrip) to better control potential sources of influence and possibly minimize the overall amount of time required to develop an effective treatment. In other cases, brief (Northup et al., 1991) or trial-based (Sigafoos & Saggers, 1995) functional analyses may be more manageable. Also, the results of indirect assessments may more quickly identify relevant test and control conditions that could be arranged within a single-function test (Iwata & Dozier, 2008). Still, classroom-based functional analyses may be impossible in some childcare and school settings. In these cases, functional analyses conducted in analogue session rooms may be the only option to determine the maintaining variables of problem behavior.

The results of Study 1 were surprising in that problem behavior for each child was shown to be sensitive to attention. In their review of functional analysis procedures and the prevalence of behavioral function, Hanley, Iwata, and McCord (2003) found escape to be the most common function of problem behavior comprising 34.2% of reviewed cases. However, as noted previously, the majority of articles reviewed by the authors included individuals with disabilities as subjects. Because of a lack of published functional analysis data for typically developing individuals (Hanley, Iwata, & McCord, 2003; Solnick & Ardoin, 2010), it remains unclear if the prevalence of behavioral function differs for typically developing individuals.

Also, our results appear consistent with the descriptive analysis findings of McKerchar and Thompson (2004). The classroom-based functional analyses demonstrated that problem behavior is sensitive to the same naturally occurring consequences common in early education classrooms. Function-based treatments were then able to validate the results of each subject's functional analysis. Although McKerchar and Thompson (2004) only analyzed teacher-child interactions, the results of the current study also found child-child interactions to be potentially influential in the maintenance of classroom problem behavior. Descriptive analysis data collected from functional analysis and treatment evaluation sessions on peer attention offered evidence for the potential influence of uncontrolled peer attention for all subjects.

The effect of conducting functional analyses in the classroom produced no substantial change in overall levels of classroom problem behavior for any subject in Study 3. One limitation of Study 3 is that data were not collected on problem behavior levels immediately before or after each functional analysis condition. Future research should collect data on classroom levels of problem behavior immediately surrounding classroom-based functional analysis session times to ensure that daily classroom data do not mask potential spikes in problem behavior immediately following functional analysis sessions.

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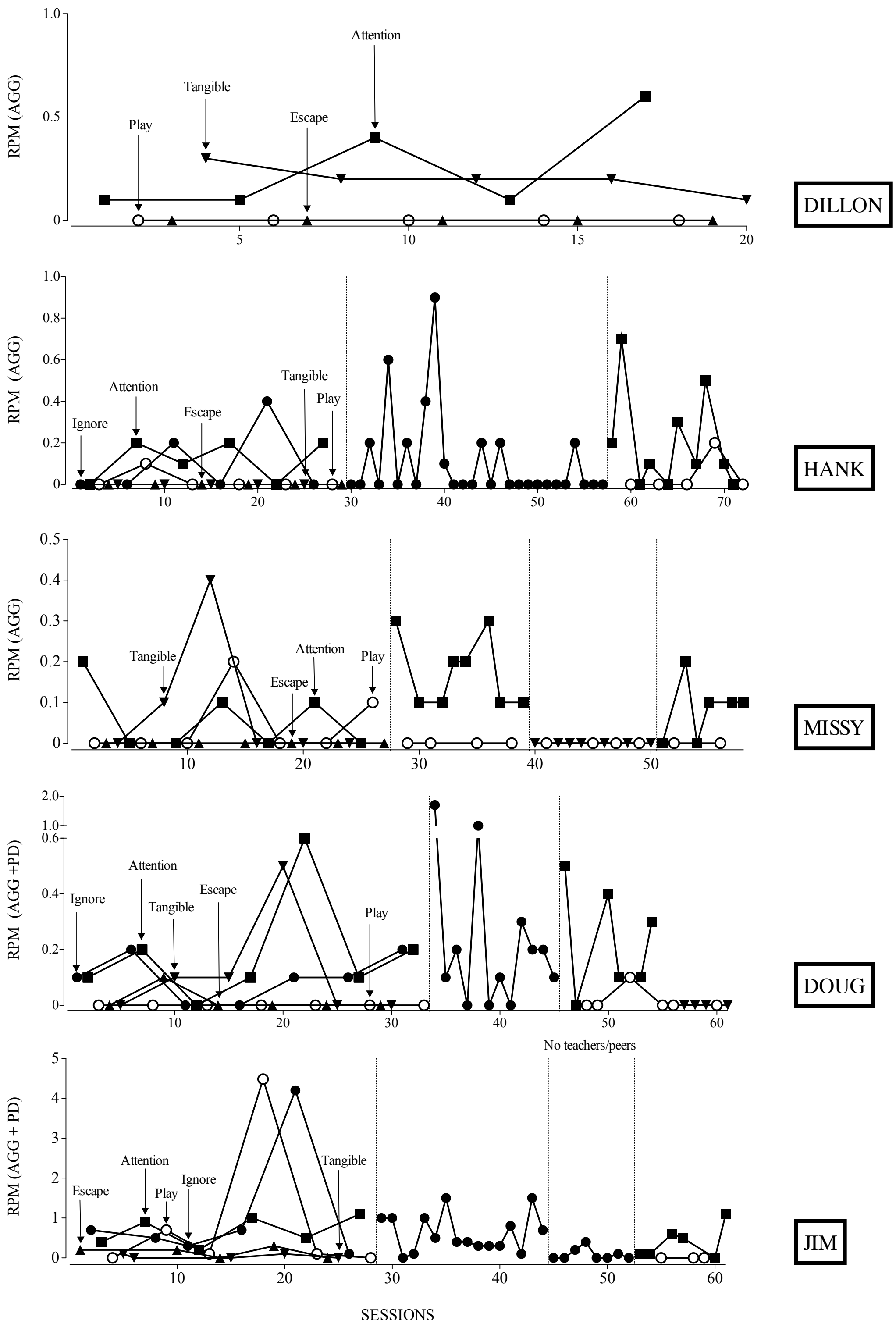

Figure 1. Functional analysis results for Dillon, Hank, Missy, Doug, and Jim with responses per min (RPM) of aggression (Dillon, Hank, and Missy) or aggression and property destruction (Doug and Jim).

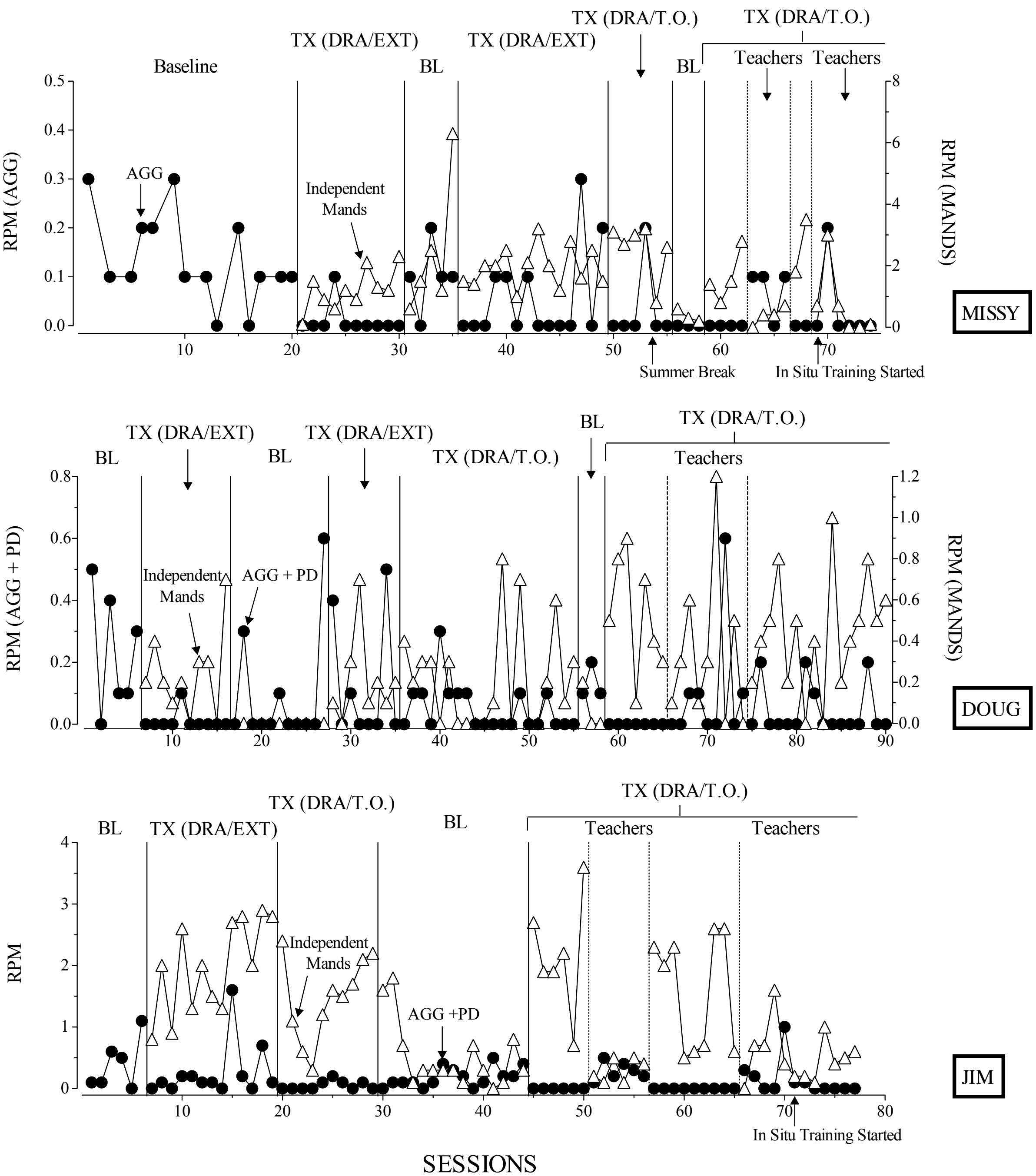

Figure 2. Treatment evaluation results for Missy, Doug, and Jim with responses per min (RPM) of problem behavior and independent mands across baseline, DRA with extinction, and DRA with timeout.

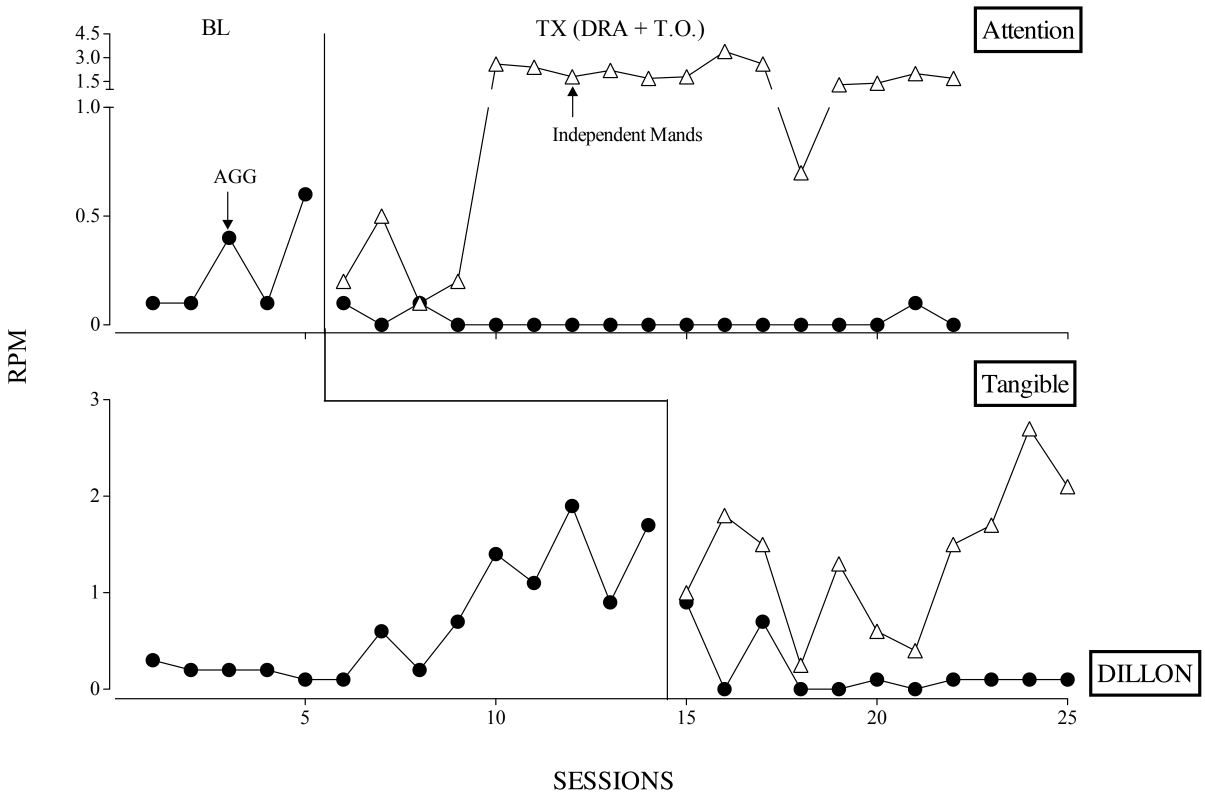

Figure 3. Treatment evaluation results for Dillon with responses per min (RPM) of aggression and independent mands across baseline and DRA with timeout.

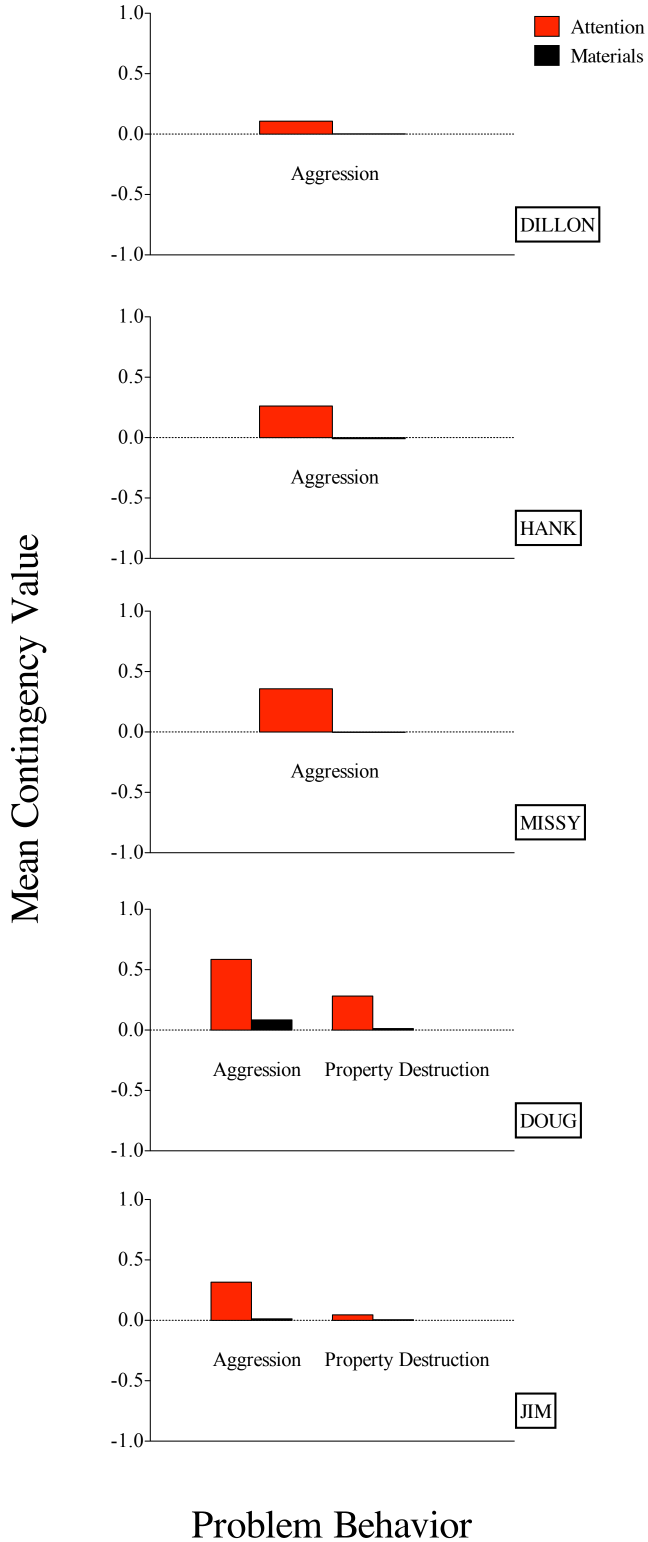

Figure 4. Mean contingency values for peer-delivered attention and materials across functional analysis and treatment sessions for Dillon, Hank, Missy, Doug, and Jim.

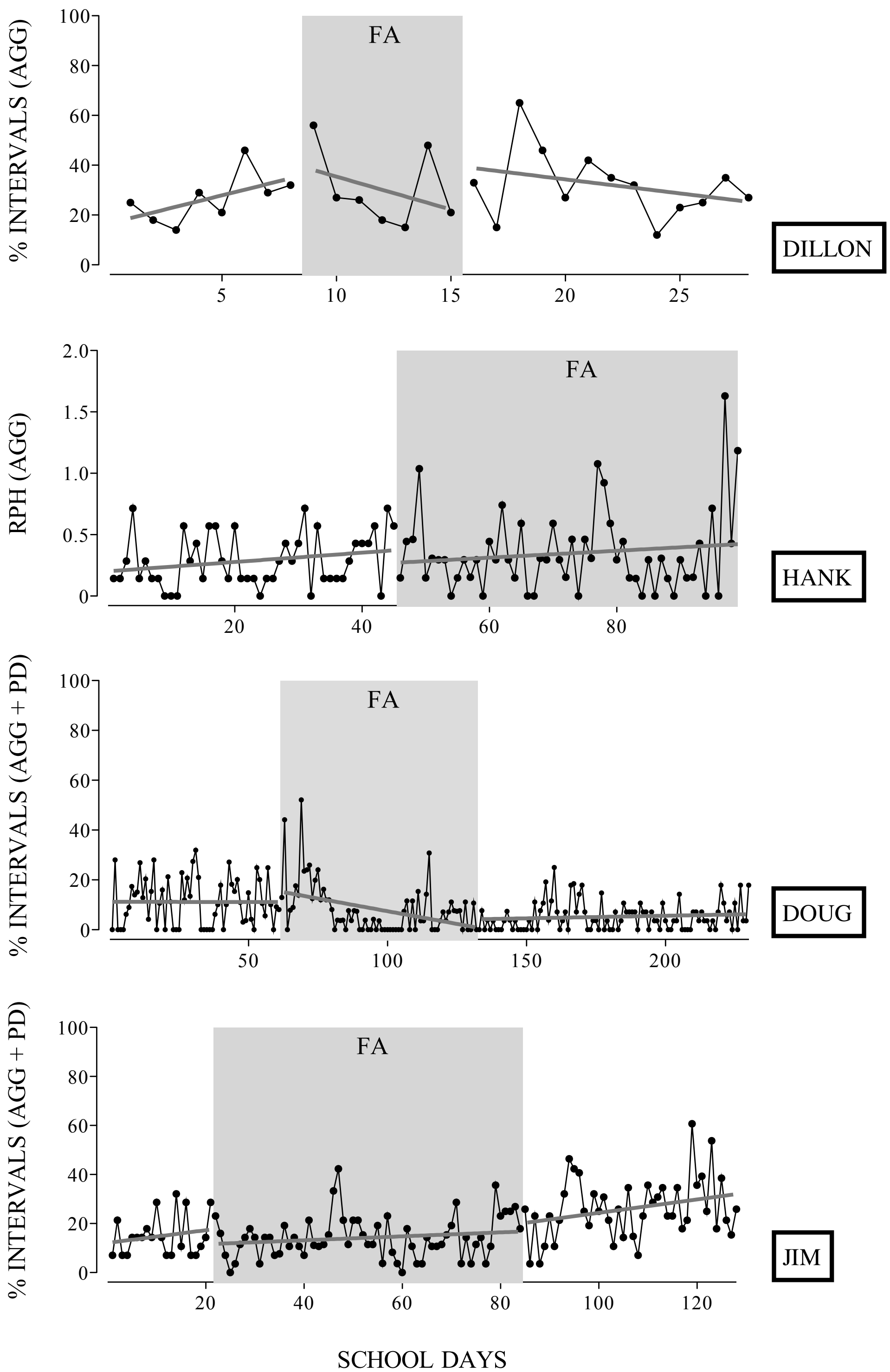

Figure 5. Classroom levels of problem behavior with liner regression lines plotted before, during (denoted by the grey box), and after school days in which functional analysis sessions were conducted for Dillon, Hank, Doug, and Jim.